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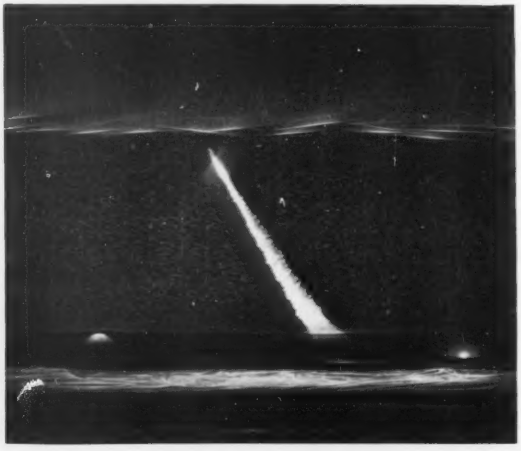
About the Cover

"Thanks for the Memories," a photographic tribute to the pressure suits of America's Space Shuttle Columbia by NASA artist Chet Jezierski. In this scene, the pressure suits of the fourth Space Shuttle mission are retired along with the press clippings of the first four Space Shuttle orbital flight test missions. The heavy protective garments and helmets that have been the normal attire for Shuttle astronauts at lift-off, re-entry and landing are no longer necessary now that Columbia is operational.

Below are selections from NASA's Space Shuttle art collection to be featured at the National Air and Space Museum Nov. 30 through July 1983. (See article p. 20-22 of this issue.) "Shuttle Launch," pencil drawing by Chet Jezierski (top); "Columbia Launch Fantasy," mixed media by Andreas Nottebahm (bottom).



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Shuttle Flight Five—Pre-Launch Statistics

Crew . . . . . Vance D. Brand, commander
Robert Overmeyer, pilot
William B. Lenoir, mission specialist
Joseph Allen, mission specialist

Orbiter . . . . . Columbia (OV-102)

Launch site . . . . . Pad 39A, Kennedy Space Center, Fla.

Launch date/time . . . Nov. 11, 1982; 7:19 a.m. EST

Launch window . . . . 39 minutes; 7:19—7:58 a.m. EST

Orbit . . . . . 185-statute-mile circular

Orbital inclination . . 28.5 degrees

Mission duration . . . 5 days, 2 hrs., 7 minutes or 122 hrs., 7 minutes

Principal cargo . . . . . Two communications satellites:
Satellite Business Systems (SBS)-C
Telesat Canada ANIK-C

Other experiments . . Getaway Special
Monodisperse Latex Reactor
3 Shuttle Student Involvement Project experiments:
Porifera Growth in Zero-G
Crystal Formation in Zero-G
Convection in Zero-G
Orbiter Experiments Package:
Aerodynamic Coefficient Identification Package
Catalytic Surface Effects
Tile Gap Heating Effects
Dynamic, Acoustic, and Thermal Environment
Infrared Imagery of Shuttle

Principal mission activity . . . . Deployment of SBS-C (flight day one) and ANIK-C (flight day two)
EVA (extravehicular activity) (flight day 4)
Orbiter Thermal Tests:
Side/Sun . . . . . 47 hours
Nose/Sun . . . . . 19 hours
Passive Thermal . . . . . 10 hours

Preferred landing site . . . . . Runway 17, Edwards Air Force Base, Calif.

Weather alternate landing site . . . . . Space Harbor (White Sands Missile Range, Northrup Strip), N. Mex.

Contingency landing sites . . . . . Dakar, Senegal
Space Harbor (White Sands Missile Range, Northrup Strip), N. Mex.
Rota Naval Station, Spain
Hickam Air Force Base, Hawaii
Kadena Air Base, Okinawa

Abort landing sites . . . . . Return-to-Launch-Site: Kennedy Space Center, Fla.
Abort-Once-Around: Space Harbor, (White Sands), N. Mex.
Transatlantic Abort: Dakar, Senegal

Landing date/time . . Nov. 16, 1982; 6:26 a.m. PST
9:26 a.m. EST

Shuttle Flight Five—A Mission of Firsts

The fifth flight of the Space Shuttle marks the first operational use of the nation's Space Transportation System. Columbia will transport into orbit two commercial communications satellites, Satellite Business Systems (SBS)-C and Telesat Canada's ANIK-C, as its first task as an operational system. Designated STS-5 (for Space Transportation System), the fifth shuttle mission is scheduled for launch on November 11, 1982 from Launch complex 39, Pad A, at NASA's Kennedy Space Center, Fla. Launch time has been set for 7:19 a.m. EST.

Significant "firsts" for Columbia on this fifth mission will include:

- First Space Shuttle flight to carry and deploy commercial satellites into space.
- First use of the Shuttle payload assist module (PAM)-D and a new ejection system.
- First flight with a crew of four astronauts.
- First flight of mission specialists aboard the Space Shuttle.
- First planned "space walk."
- First demonstration of the Extravehicular Mobility Units in space.

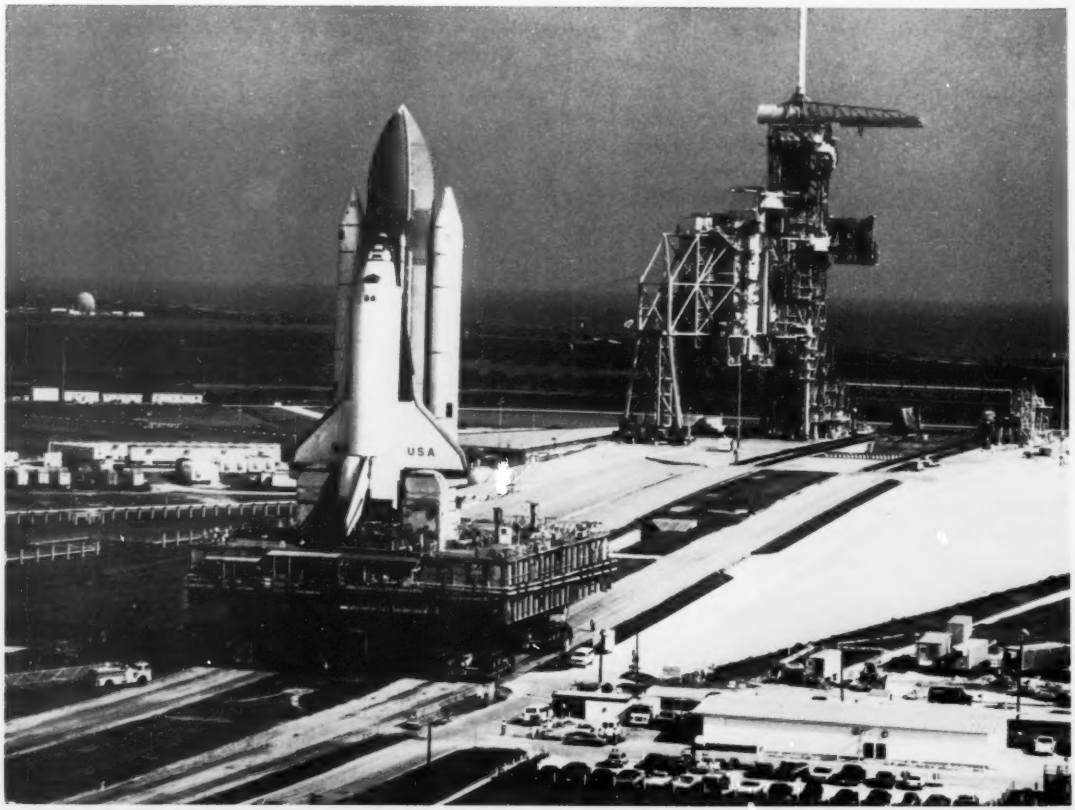
Flight crew for STS-5 is comprised of Commander Vance Brand, 51; Col. Robert Overmyer, 46, pilot; and Dr. William B. Lenoir, 43, and Dr. Joseph Allen, 45, mission specialists. The mission specialists will perform the first extravehicular activity (EVA) ever attempted on a Shuttle flight. Lenoir and Allen will simultaneously go

out into Columbia's cargo bay where they will spend approximately three hours testing their space suits' cooling and communications systems, and practicing procedures that might be used for an actual contingency space walk to close balky payload bay doors, repair thermal protection tiles or retrieve a satellite.

Brand was command module pilot of the Apollo Soyuz Test Project (ASTP) flight conducted July 15–24, 1975. He has logged 217 hours and 28 minutes in space. Overmyer was selected as a NASA astronaut when the U.S. Air Force Manned Orbiting Laboratory program was canceled in 1969. He has served on the support crews for Apollo 17 and the ASTP, and was the prime T-38 chase plane pilot for several of the approach and landing tests. Lenoir was selected as a NASA scientist astronaut in 1967. He was backup science pilot for the Skylab 3 and 4 missions and has supported the Space Shuttle program in the areas of payload deployment and retrieval. Allen was selected as a scientist astronaut in 1967. He was a mission scientist while a member of the astronaut support crew for Apollo 15.

Columbia will be launched into a 185-statute-mile circular orbit above the Earth with an inclination to the equator of 28.5 degrees.

Tentatively, the launch window for STS-5 will have a duration of 39 minutes, opening at 7:19 a.m. and closing at 7:58 a.m. EST. The shortness of the window on this flight is due to a daylight landing constraint at Edwards, as well as the other contingency landing sites, and to obtain the proper orbital positioning for deploying the two commercial satellites on the first and second days of the flight.



Rollout 5—Rollout of orbiter Columbia on Sept. 21 for the fifth Space Shuttle launch, now scheduled for 7:19 a.m. EST on Nov. 11.

Columbia will operate in several different attitudes during the 122-hour flight to expand NASA's knowledge of the thermal characteristics of the spaceship. On previous flights, the Columbia has circled the Earth with its nose, tail, bottom and payload bay pointed toward the Sun. On this mission, Columbia will spend 47 hours with its side turned to the Sun, and another 19 hours facing the Sun with its nose propped up about 10 degrees. The remaining time will be spent in a payload bay-to-earth (ZLV) attitude for the deployment of the satellites and the last 10-12 hours before deorbiting.

Scheduled duration for flight five is 5 days, 2 hours, 7 minutes, or 122 hours, 7 minutes. A nominal landing would occur on November 16 at 9:26 a.m. EST, approximately seven minutes after sunrise at Edwards. Columbia again will aim for a lakebed landing on runway 17 at Edwards Air Force Base, Calif. The highest landing priority will be the first completely automated landing of an orbiter from about 20,000 feet to nose wheel touchdown.

Principal cargo to be carried on the fifth Shuttle mission are two commercial communications satellites; Satellite Business Systems (SBS)-C and Telesat Canada's ANIK-C. Other items to be carried in the cargo bay will be a getaway special canister and the development flight instrumentation package. Experiments scheduled to fly in the orbiter's mid-deck include the monodisperse latex reactor and three Shuttle student involvement project experiments. The induced environment contamination monitor and remote manipulator arm have been removed for this flight.

Satellite Business Systems (SBS)-C is the third in a series of business communications satellites, while Telesat Canada's ANIK-C is the first of a trio of satellites that will provide domestic communications services for Canada. Both the SBS-C and ANIK-C spacecraft are built by Hughes Aircraft Co., El Segundo, Calif. The satellites each measure about 2.1 meters (7 feet) in diameter and 6.3 meters (21 feet) tall when deployed in orbit. SBS and Telesat Canada each will pay about $8 million for the launch under a launch services agreement with NASA.

The Shuttle Payload Assist Module (PAM)-D, and a new ejection system will be used for the first time on flight five. A modified version of the PAM has been used as the third stage of NASA's Delta rocket to propel a variety of satellites to geosynchronous altitude.

SBS-C will be the first spacecraft launched out of the cargo bay. It will be deployed about eight hours after liftoff, when the orbiter is over the Atlantic Ocean. The ANIK-C spacecraft will be released on the second day of the mission, on about orbit 22, while Columbia is over the Pacific Ocean near Hawaii.

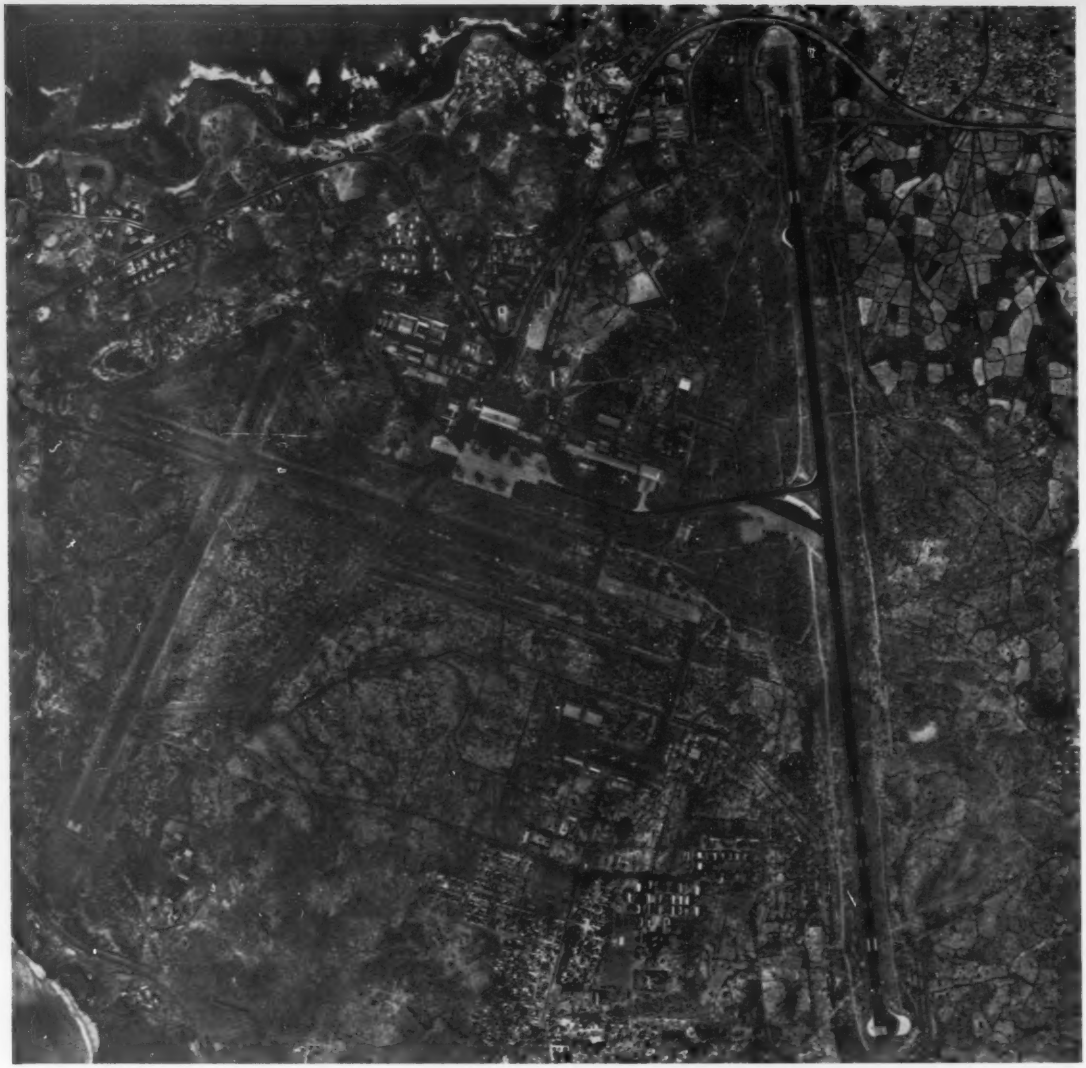
During the final pre-ejection sequence, the orbiter will be maneuvered into a deployment attitude with the open bay facing the direction desired for firing the PAM motor. A clamp is released by explosive bolts and the spinning payload pops out of the bay at a rate of about two and one-half feet-per-second.

At deployment, the PAM is armed to fire automatically in 45 minutes. About 15 minutes after deployment, the orbiter will perform an evasive maneuver to ensure it is at least 8 to 10 miles away from the satellite when the PAM ignites. The PAM motor firing raises the apogee of the spacecraft to about 22,300 miles. On a selected apogee, or high point of the transfer orbit, a solid propellant motor on board each spacecraft is fired to circularize the orbit at the geosynchronous altitude.

After the two satellites have been successfully deployed, the first space walk of the Shuttle program will be conducted. Allen and Lenoir will don pressure suits called extravehicular mobility units (EMU) and backpacks with portable life support systems. They will enter the payload bay through an airlock, hook up safety tethers and traverse down opposite sides of the 60-foot-long enclosure. Holding onto handrails, they will inspect the cargo bay and then move to a stationary tool box and remove a mini work station that will tether them at various worksites. In view of the payload bay cameras, they will test stationary and portable foot restraints, torque and box wrenches, scissors, cutters and ratchet tools to be used on future flights.

The Monodisperse Latex Reactor, one of Columbia's mid-deck experiments, has been carried into orbit on the third and fourth Shuttle flights. Satisfactory results were obtained from the experiment on the third mission. On the fourth flight, some scientific data and experiment objectives were obtained despite an equipment problem. The experiment is used to develop large, identical-sized latex particles. These latex particles may have major medical and industrial research applications.

The Getaway Special scheduled to fly on the fifth Shuttle flight is the first payload of the MAUS project, part of the material science program of the German Ministry of Research and Technology. This experiment will, for the first time, use X-ray recordings to investigate the behavior of metallic dispersions—homogeneous mixtures of two metals. Two metals that are liquid at room temperature, gallium and mercury, will be taken into orbit inside the getaway special canister. A sample will be heated to 220 degrees C (396 degrees F) and kept at that temperature for a



Emergency Landing—Aerial view of Yoff Airfield, Dakar, Senegal, the transatlantic landing site for the fifth Space Shuttle ascent abort. The main runway, running vertically on the right side of the photo measures 3,550 meters (11,647 feet) in length and 45m (148 ft.) in width.

day. The mercury will slowly dissolve into solution with the gallium, much like sugar into a steaming cup of coffee. When the heater is turned off, the sample will cool. On Earth, the mercury would fall out of solution. But in orbit, without gravity, it will not fall to the bottom of the heating chamber and the result will be a mixture of the two metals that is uniformly distributed on a microscopic scale.

Three Shuttle student involvement project experiments will be flown on the fifth Shuttle mission.

In "Growth of porifera in zero-gravity," by Aaron K. Gillette of Winter Haven, Fla., mechanically separated cells of porifera (the common sponge) are to be studied in Columbia's zero gravity to gain better understanding of intercellular communication. For "Formation of crystals in weightless environment," by Michelle Issel,

Wallingford, Conn., crystal formation will be observed by heating and then cooling a saturated sodium chloride solution in the weightless environment of the Shuttle. If successful, the process of producing geometrically perfect crystals would be useful to the electronic and other industries. "Convection in zero gravity," by D. Scott Thomas, Johnstown, Pa., will use the weightless environment of the orbiter to study the properties of tension-driven convection in the absence of buoyancy-driven convection. This experiment will be an extension and comparison with similar experiments.

As on previous missions, several orbiter experiments program (OEX) experiments will be flown. These research experiments are designed to record specific data to verify the accuracy of wind tunnel and other ground-based simulations made prior to flight; verify ground-to-flight extrapolation methods; and verify theoretical computational methods. The data will also be useful to further certify the Shuttle and expand its operational envelope. The OEX experiments include:

- Aerodynamic coefficient identification package—to collect aerodynamic data during the launch, entry and landing phases of the Shuttle and establish an aerodynamic data base for verification of and correlation with ground-based data.
- Catalytic surface effects—to verify predictions of the effects of surface catalytic efficiency on convective heating rates.
- Tile gap heating effects experiment—to further investigate the heating phenomena associated with the gaps between tiles to produce a design that will result in heating rates lower than those of the baseline system.
- DATE (Dynamic, Acoustic and Thermal Environment Experiment)—to collect information for use in making credible predictions of cargo bay environments.
- IRIS (Infrared imagery of Shuttle)—will obtain high-resolution infrared imagery of the orbiter during reentry from which surface temperatures and hence aerodynamic heating may be inferred. The imagery will be obtained utilizing a 91.5-cm (36-inch) telescope mounted in the NASA C-141 Gerard P. Kuiper Airborne Observatory positioned appropriately along the entry ground track of the orbiter.

Fifth entry of the Columbia will follow the same course in returning from orbit as did earlier flights: retrofire over the Indian Ocean, atmosphere entry over the western Pacific Ocean, transition to aerodynamic controls in the atmosphere, and a landing as an aircraft. The 3-mile long paved runway at Kennedy Space Center will be the Abort-Once-Around (AOA) and also a contingency landing site.

Columbia's next mission will be STS-9, now planned for launch in September 1983, the first flight of the European-developed Spacelab. Columbia will remain at Kennedy Space Center for major modifications to prepare it for that mission. Orbiter 099, Challenger, is scheduled to make flights 6, 7 and 8 in January, April and July 1983.

Shuttle Mission Five's Getaway Special Payload

Aboard Columbia for the fifth Space Shuttle mission will be a German materials processing experiment. The experiment is the first payload of MAUS (Materialwissenschaftlich Autonome Experimente unter Schwerelosigkeit), part of the material science program of the German Ministry of Research and Technology (Bundesministerium fuer Forschung und Technologie (BMFT)), and the second payload within NASA's Getaway Special program to fly aboard the Space Shuttle.

The experiment, the first of its kind, will use X-ray readings to investigate the behavior of metallic dispersion. An additional objective of the MAUS project is verification of the standard service system, a German-designed payload support structure consisting of a mounting structure, power supply, experiment control, data acquisition, and housekeeping sensors.

X-rays will radiate through two metallic samples, gallium and mercury, which exhibit a miscibility gap in their liquid state. The X-ray process will record periodically their appearance in the liquid state on photographic film during microgravity processing. Elevated temperature treatments will be used to bring these metals into solution; the time needed for this diffusion until complete mixing is achieved will be recorded.

Understanding the physical processes which occur in liquid metals shortly before or during solidification has been hampered by the lack of direct optical observation. Metallic samples which were processed and solidified in earlier space missions had to be analyzed after their return to Earth on polished cross sections. The MAUS Getaway Special utilizing X-ray technology should revolutionize this data collection process.

The next five MAUS payloads are scheduled to fly on the seventh flight of the Shuttle in April 1983, integrated into SPAS 01 (Shuttle Pallet Satellite, a German industrial project), and OSTA 2 (a cooperative NASA-BMFT project). BMFT paid NASA $10,000 to fly the 200-pound MAUS getaway special canister aboard the fifth Shuttle flight.

Technicians examine the first in a series of West German materials processing experiments to be flown aboard the Space Shuttle. This experiment, the second Getaway Special to be sent into space, will take X-ray photographs of gallium and mercury samples as they are heated to the melting point and then allowed to cool at a set rate.

ERNO, the main contractor for the standard service system, has fabricated ten flight units which will be flown on several future Shuttle missions. The MAUS project is managed by the German aerospace research company DFVLR (Deutsche Forshungsund Versuchsanstalt fuer Luft and Raumfart); principal investigator is Dr. Guenther Otto, DFVLR, Institute for Space Simulation.

Shuttle Flight Five Student Experiments

Three experiments, part of the Shuttle Student Involvement Project, cosponsored by NASA and the National Science Teachers Association, are scheduled to be flown aboard the fifth Shuttle flight: **Growth of Porifera in Zero-Gravity,** Aaron K. Gillette, Winter Haven, Fla.; **Convection in Zero-Gravity,** Scott Thomas, Johnstown, Pa.; and **Formation of Crystals in a Weightless Environment,** Michelle A. Issel, Wallingford, Conn. These experiments were chosen from among 1,500 proposals suggested by high school students from across the nation.

Gillette, a junior at Winter Haven Senior High School when he proposed his experiment, is now a freshman at Western Carolina University, Cullowhee, N.C. He will examine the effects of near weightlessness on the formation of sponges. Gillette hypothesizes that cells which form sponges will have difficulty doing so if gravity is not present to enable them to join properly together.

The experiment is composed of 18 bags, each with a solution of separated sponge cells and a packet of special ions, which when released, will enable the cells to begin regrouping. On Earth, once the cells are separated and these ions released, the cells regroup or "reaggregate" to form new sponges. This experiment will determine whether the same process occurs in a weightless environment. Gillette's corporate sponsor is Martin Marietta Aerospace, Orlando Div., where a similar experiment will be performed to provide ground control data.

Thomas, now a freshman at Utah State University, was a junior at Richland Senior High School when he proposed his experiment to study liquid surface tension convection in micro-gravity. Surface tension is the "skin" on a liquid surface, a process that allows a spider to "skate" on water, for example. Surface tension induces flow patterns (convection) in liquids that are heated. Because gravity affects convection on Earth, it is better to study surface tension induced convection in orbit where gravitational effects can be minimized.

For this experiment, up to 15 experimental runs will be conducted in the hour of astronaut time provided. Eight aluminum pans of approximately ¾, 3 and 4 inches in diameter with embedded heaters will hold from 1 to 10 millimeter depths of Krytox oil. The astronaut will inject the oil into the pans with syringes. Video tape, temperature and time readings will be taken of the liquid in which aluminum powder is suspended for visualization.

Data obtained from the experiment will be compared to theoretical predictions and hopefully will lead to a better understanding of surface tension flows in near zero-gravity. Possible applications include a better understanding of certain areas of material processing in space. Thomas' corporate sponsor is Thiokol Corp., Wasatch (Utah) Division.

Issel is a freshman at American University. As a junior at Mark T. Sheehan High School, Issel proposed an experiment to study crystal growth in space, attempting to grow a geometrically perfect crystal in micro-gravity, a feat made difficult if not impossible by Earth's gravity. The experiment involves cooling a triglycine sulfate seed while heating the solution of triglycine and distilled water in which it is saturated. In space, the seed will remain suspended in the solution and grow freely, whereas on Earth the seed's growth is affected by gravity. Issel predicts that in space surface

growth of the seed should be uniform and a geometrically perfect crystal should form. If successful, the results will prove beneficial to the electronics and computer industries. Issel's corporate sponsor is Hamilton Standard, Windsor Locks, Conn.

The Shuttle Student Involvement Project is designed to stimulate the study of science and technology in secondary schools. The first such experiment flew aboard Columbia during the third Shuttle flight in March.

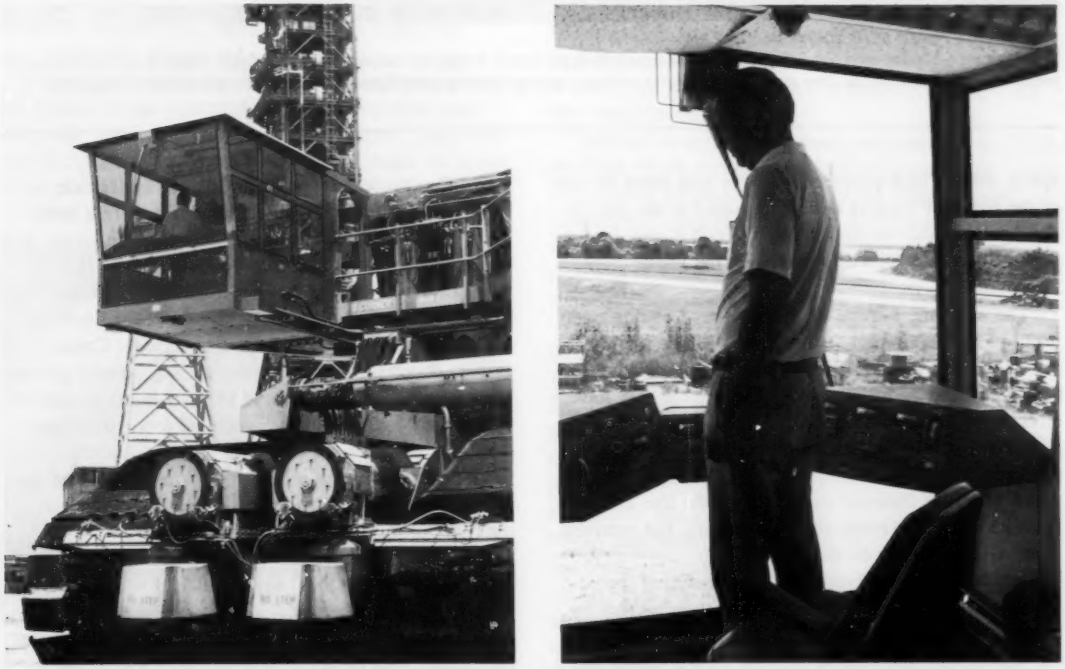
The third project competition is now underway. Requests for entry materials should be sent to: National Science Teachers Association, 1742 Connecticut Ave. NW, Washington, D.C. 20009. Entries are judged at regional and national levels with experiments chosen for Shuttle flight selected from the national finalists.

Behind the Wheel of a 6.3-Million-Pound "Tortoise"

Dick Beck is one of the world's most unusual chauffeurs—not because of who he drives around but because of what. The Boeing Services International engineer is among a select handful of men entrusted to drive the Space Shuttle on its 3½-mile journey from Kennedy Space Center's massive Vehicle Assembly Building to launch pad 39A.

Perched atop a mobile launcher platform, the assembled Space Shuttle is transported to the pad on one of the two giant tracked vehicles nicknamed the mighty tortoise. Formally known as crawler transporters, the 6.3-million-pound vehicles are operated and maintained by Boeing Services International crews who have the responsibility of delivering the Space Shuttle to its launch pad safely and on time.

Beck was at the steering wheel during the most critical phases of Space Shuttle Columbia's rollout to the pad for its first three flights. It may not seem like far to go, but time "crawls" when the Space Shuttle is making its trip to the pad—speed limit for the crawler transporter is one mile per hour. "You don't think one mile an hour is fast until you're rumbling along with 11 million pounds and realize that if you take your mind off what you're doing, you'll be heading for the river instead of the pad," says Beck. His first trip down the



Back view of one of two crawler transporters (left) which carry the Space Shuttle from Kennedy Space Center's Vehicle Assembly Building to launch pad 39A. The one-mile-per-hour vehicles are operated and maintained by Boeing Services International crews at Kennedy. Looming in the background is the top portion of an Apollo launcher. Standing at the wheel in the crawler transporter cab (right), Boeing Services engineer Dick Beck monitors the movement of the transporter. Like at the helm of a ship, Beck gets a better view of the crawlerway if he stands on the job.

Fire Training—Mission specialist Bill Lenoir (second from left) in pre-launch firefighting training at Kennedy Space Center as part of pre-launch preparation. All Space Shuttle crew members and support personnel undergo training in firefighting at the Center's special fire training area.

space center's rock-paved crawlerway was when the last of the Saturn V rockets were transported to the pad for the Apollo-Soyuz mission in 1975. Beck is now lead driver of those qualified to maneuver the giant transporters.

"The first time I drove the transporter, I couldn't get it out of the parking lot," says Beck. Not everybody with a driver's license can hop into the cab of a crawler transporter and go rolling away. The vehicle may have a steering wheel, disc brakes and a windshield, but that's where its similarity to an automobile ends. Eight engineers have been certified to drive the squat vehicles, which resemble flattened tanks and handle like a ship. Each had to pass written exams to qualify, but received their vehicle training on the job.

They take turns relieving one another during the 5½-hour trip to the launch pad. While the crawler transporter can "cruise along" at one mile per hour on the crawlerway, the vehicle must be *inched* slowly out of Kennedy's Vehicle Assembly Building and up the pad ramp. During these critical phases, drivers must keep the crawlers speed to *1/10 of a mile an hour or less.*

Beck and the other drivers only sit in the drivers seat when the crawlers are at a stop. When the vehicle is moving, they stand at the wheel as if it were a helm. "It's the only way you can see where you're going. And even then, the windshield isn't much use," says Beck. He uses a couple of hydraulic hoses near the base of the crawler as a reference point which he keeps lined up with the grassy medium of the crawlerway. Crawler drivers depend heavily upon the Boeing crawler ground crew who walk alongside and in front of the crawler to provide vital guidance to drivers and to keep a close watch on the track for any signs of a breakdown.

"When we were rolling out the Saturn V, one of the pins holding the tracks together came about half way out. One of the guys on the ground knocked it back in with a sledge hammer and we continued on. Driving is just one part of the job," says Beck. "It takes everybody pitching in to do the task."

In the assembly bay and at the top of the pad where movement must be accurate to within a few inches it takes the close attention of everybody on the team to ensure precision. It takes about a dozen engineers, technicians, and mechanics to man the crawler transporter.

Miniature TV Camera to be Used on Fifth Shuttle Mission

A miniature television camera, its postage-stamp-size lens peeking over Astronaut Joseph Allen's helmet, will give viewers on Earth a first-hand look at what astronauts see during a space walk on the next Space Shuttle flight in November.

The hand-size, 1.1 kilogram (2½-pound) camera will be used during a 3½-hour extravehicular activity on a five-day flight of Columbia after two communications satellites have been deployed. During the space walk, mission specialists Joseph Allen and William B. Lenoir will test onboard tools in the orbiter's payload bay while the camera relays the action to Earth or into Columbia's cabin.

The mini-camera uses a solid state image sensor instead of a vacuum tube and is housed above the helmet's extravehicular visor assembly. Solid state is less complex, and lighter, requiring less power. The camera weighs half that of a similar vidicon tube unit, and transmits live, black and white television scenes. The lens has a 19.7 mm focal length with a 32-degree horizontal field-of-view and normal depth of field from 80 centimeters (32 inches) to infinity. A close-up lens adapter is snapped into position by the astronaut for focus from 30 to 80 cm (12 to 32 in).

To leave the Orbiter Columbia, Allen and Lenoir will don pressure suits—extravehicular mobility units and backpacks with portable life support systems. They will enter the payload bay through an airlock, hook up safety tethers and Allen will turn on the TV camera and lights also mounted in his helmet. Clinging to handrails, Allen and Lenoir will inspect the payload bay, move to a stationary tool box and remove a mini-work station which will tether them at various worksites.

In view of the helmet and payload bay cameras, they will test stationary and portable foot restraints, torque and box wrenches, scissors, cutter and ratchet tools to be used on future flights. They will also test two winches mounted on the forward and aft bulkheads. The winches manually close the payload bay doors in the event of a door-drive failure.

The helmet camera allows crewmen inside the spacecraft to view the hardware being inspected and permits Commander Vance D. Brand and Pilot Robert F. Overmyer to evaluate the activity.

The miniature TV cameras were developed for the Air Force and produced by Fairchild Weston Systems, Inc., Syosset, N.Y. and are modified for Space Shuttle flight.

Mission specialist Joe Allen dons a special space suit helmet that houses a miniature solid-state television camera. The postage-stamp size lens is at upper right of the helmet. Allen will use this camera during the mission specialist's "spacewalk" scheduled for flight day four of the fifth Space Shuttle mission.

Pre-Launch Protection of the Space Shuttle

Each time the Space Shuttle has lifted from the launch pad, it has been protected by a flying "Spectre." Rather than stemming from supernatural powers however, the airborne protection comes from the U.S. Air Force Reserve.

"Spectre" is the name of some sophisticated AC-130A gunships which perform aerial surveillance of the launch area. Flown by citizen-soldiers of the 919th Special Operations Group from an Eglin Air Force Base auxiliary field, the aircraft use a variety of sensitive detectors to make sure no unauthorized persons, vehicles or vessels pose a safety hazard to the launch.

"It's invaluable to us to have the 919th available for Space Shuttle launches," said Capt. Dave Colchin, the Air Force Surveillance Control Officer for Space Shuttle missions. "The infrared scanners and low light level television are especially useful in clearing both land and sea areas." Colchin said that the Spectre aircraft work for Air Force range safety during Space Shuttle and expendable rocket launches, but also are responsible to NASA and the Coast Guard for launch surveillance functions.

"This is a good example of the tremendous support that the Department of Defense provides to NASA," said Ken Lopez, Kennedy Space Center's Chief of Fire and Security. "It's a very necessary service that we'd have great difficulty in providing for ourselves."

All Space Shuttle launches to date have made use of the 919th's Spectre gunships to patrol the immediate

U.S. Air Force AC-130A gunship, part of the 919th Special Operations Group (Air Force Reserve) from Eglin Air Force Base, Fla., used for range safety and launch surveillance functions before a Space Shuttle launch.

launch area as well as to assist the Coast Guard in clearing the flight corridor that extends to the solid rocket booster splashdown area about 160 miles downrange. Two aircraft are normally airborne during a launch, with a third serving as a ground spare.

The aircraft can also serve as search and rescue scanners if the Space Shuttle should be forced to ditch or crash off the coast and a search had to be mounted.

The electronic, radar, infrared and optical surveillance abilities of the aircraft, developed to locate enemy forces and vehicles at night and through dense vegetation during the Vietnam war, are highly adaptable to provide many kinds of aerial observation and search and rescue services.

In the past few years, the 919th has used its special capabilities to provide aerial assistance in widely disparate circumstances. One example occurred early in the unit's transition to the AC-130 in 1975. During an otherwise routine training flight over the Eglin military reservation, a sprawling complex that includes most of the Florida panhandle, one of the unit's aircraft detected an unauthorized vehicle operating far below.

By radio, the aircraft crew alerted and then directed wildlife agents directly to the suspect car for a literal "red-handed" arrest as illegal poachers were dressing a deer carcass.

On another occasion, also over the Eglin area, a crew of 919th Reservists was diverted from a training flight to assist at a train wreck.

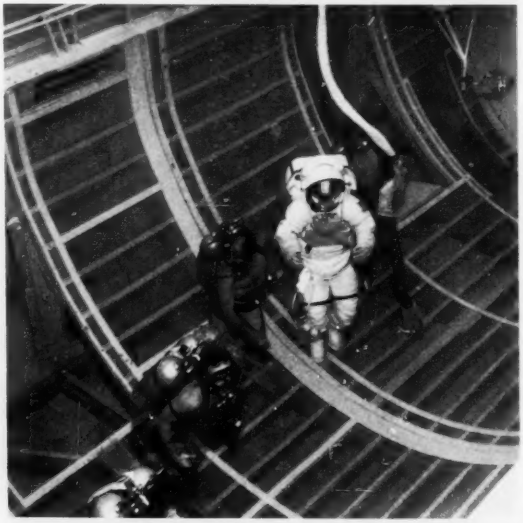
Several cars of a train had derailed in the night, and chemical fumes and toxic fumes drifted invisibly through the blackness, endangering citizens, firefighters and rescue personnel alike. The AC-130 made an infrared survey of the wreck site to locate fires and dangerously hot tank cars, and also used low-light-level television to track the movement of the toxic clouds.

In addition, the plane's 2,000 watt searchlight provided aerial illumination for firefighters at the scene. Working through the night, other of the units aircraft provided continuous coverage by flying in relays until the danger had passed.

Most of the time, however, the unit's training flights are used to build skills in the art of close air support. In wartime, the unit's aircraft could be used to help protect and defend friendly troops in close contact with the enemy, or for the destruction of vehicles and supply sites.

New NASA Personnel and Appointments

NASA has selected a new Chief Scientist, Headquarters, Washington, D.C.; a new Deputy Director of the Goddard Space Flight Center, Greenbelt, Md.; and announced two key appointments in the Office of Space Flight. Dr. **Frank B. McDonald** has been named **Chief Scientist; John J. Quann** has filled the



Work in Zero-G—Scuba divers assist mission specialist Bill Lenoir during an exercise in Johnson Space Center's Weightless Environment Training Facility. Lenoir is fully suited and tethered, practicing chores for his extravehicular activity scheduled for flight day four on the fifth Space Shuttle mission.

position of **Goddard's Deputy Director** and in the **Office of Space Flight, Isaac T. Gillam IV** has been appointed **Assistant Associate Administrator for Policy** and **Richard Wisniewski** as **Assistant Associate Administrator for Institutions.**

McDonald had formerly served as Chief of Goddard's Laboratory for High Energy Astrophysics since 1970. In that role he was project scientist on nine NASA satellite programs including Explorers 12 and 14; IMP (Interplanetary Monitoring Platform) 1-6; and HEAO-1; and principal investigator for many space experiments such as cosmic ray and energetic particles flown on Pioneers 10 and 11, Helios and Voyager spacecraft. During the past year McDonald has been detailed to the White House Office of Science and Technology Policy as a senior policy analyst. As Chief Scientist he will serve as the principal advisor to the Administrator and other senior officials on scientific aspects of NASA programs.

Prior to his new appointment as Center Deputy Director, Quann had been Director of Goddard's Mission and Data Operations Directorate since Oct. 1980. In 1974 he was selected to create and head the Information Division of Goddard's newly formed Executive Office. This Division developed a domestic/decision information display system which facilitated statistical analysis.

Gillam, since last October, has served as Special Assistant to the Administrator for Space Transportation Systems with a special assignment to the White House Office of Science and Technology to assist in the formulation of the National Space Policy. Prior to his assignment at Headquarters, Gillam was Director of NASA's Dryden Flight Research Facility, Edwards, Calif., from June 1978 to October 1981.

Wisniewski had been Acting Director, Institutions and Administration Division in the Office of Space Flight since February 1981. He has held several key assignments at Headquarters including Assistant Associate Administrator for Management and a member of the Headquarters management team which initiated the manned space flight program. Wisniewski began his NASA career as an aeronautical engineer at Lewis Research Center, Cleveland, in 1955.

Inspector General Activities

The following reports are of completed recent investigations by NASA's Office of the Inspector General.

Defective Pricing

As part of an earlier audit conducted by the Defense Contract Audit Agency for NASA, a credit of $13,000 was issued to NASA by a major contractor because of defective pricing. A recent review of the same contract by Defense Contract Audit Agency found further defective pricing in indirect costs. As a result of these findings, the contractor has provided NASA with an additional check for $70,452.

Theft of Government Property

Following receipt of a tip from a local police department, NASA's Office of the Inspector General opened an investigation which resulted in a three-year prison sentence for a former NASA contractor employee.

The employee, involved with the repair of computer terminals, devised a creative scheme for obtaining one illegally. Investigation by the Office of the Inspector General revealed that the employee removed a NASA computer terminal for repair and shortly thereafter reported the terminal stolen to appropriate officials. The employee later legitimately picked up a second terminal for repair, substituted the stolen terminal when the "repair" was completed, and converted the second terminal for personal use. As a result of the investigation, the accused pleaded guilty to possession of stolen NASA property and was sentenced to three years in state prison.

Remarks by Judge William P. Clark National Security Advisor

Symposium on the 15th Anniversary of the Outer Space Treaty

National Academy of Sciences September 15, 1982

The Outer Space Treaty is at least as relevant today as it was when it entered into force in 1967. Its drafters were inspired by the romance and great promise of man's entry into space. They were keenly aware of all mankind's interest in the progress of exploration and use of outer space. They were convinced that activities in outer space should be carried on for the benefit of all people. They were confident that broad international cooperation in space would develop mutual understandings and strengthen relations between states.

These concepts are still viable today. And in fact, the President's new space policy announced on the Fourth of July finds many of its roots in the Outer Space Treaty. Our new policy provides a framework for a vigorous and farsighted space program. Our goals for space are ambitious, but achievable. The great French scientist, Louis Pasteur, once said, "Chance favors only those minds which are prepared."

History has taught us that soothing nostrums, and instant and easy solutions, rarely work. Rather, we must combine our practical experiences with intellectual vision to devise thoughtful and constructive policies that lay foundations for future decisions. The President's space policy effectively lays the foundation that will guide our efforts in space in the years to come.

I'd like to expand on some of the principles underlying the conduct of the U.S. space program. The President has enunciated *a national commitment to the exploration of space in support of our national well being*. In short, the United States is committed to maintaining international leadership in space and to capitalizing on its tremendous potential. We are becoming increasingly dependent on space systems to provide vital services and perform essential missions in both the civil and national security areas. Our programs in space yield the benefits of scientific knowledge and understanding of the Earth, the solar system, and the cosmos.

Historically, international participation in United States space exploration programs has been extremely significant. We will continue to promote, in the national interest, international cooperation in our space program. Cooperation has permitted us to reduce mission costs and to gain access to valuable foreign scientific and technological expertise. International space collaboration also serves broad national foreign policy goals of retaining and strengthening positive, productive relationships with the many countries, both developed and developing, which are benefiting from U.S. space programs. Moreover, widespread international participation in U.S. civil space activities underscores the essential openness of our program. This contrasts sharply with the limited nature of the Soviet program.

At the same time our national program is developing, a highly competitive environment is evolving in the private sector. Space is becoming a workplace laboratory with real economic benefits, and we are encouraging private sector investment and involvement in space activities. Competitive modern communications systems are absolutely dependent on private sector satellites. The desirability of commercializing remote sensing is being assessed. The space launch business, which depends heavily on hardware and services from many U.S. industrial firms, has great potential.

On the last point, let me emphasize that the U.S. is fully committed to maintaining world leadership in space transportation. In his Independence Day address, President Reagan stated that the "United States must look aggressively to the future by demonstrating the potential of the Shuttle and establishing a more permanent presence in space." The Shuttle is a vital element of the U.S. space program, one which is being afforded the attention and concern appropriate to a critical space resource. Because the Shuttle is a national resource, the Shuttle program requires—and is receiving the support of the public and many government departments and agencies.

Our space policy acknowledges the importance of space activities in pursuit of our national security goals. National security space programs shall support such essential functions as command and control, communications, navigation, environmental monitoring, warning, and surveillance. The President has also declared that "The U.S. will continue to study space arms control options. The United States will consider verifiable and equitable arms control measures that would ban or otherwise limit testing and deployment of specific weapons systems, should those measures be compatible with United States national security."

The United States civil space program is second to none and we intend to maintain it that way. We will expand our knowledge of the Earth, its environment, the solar system and the universe. At the same time, we

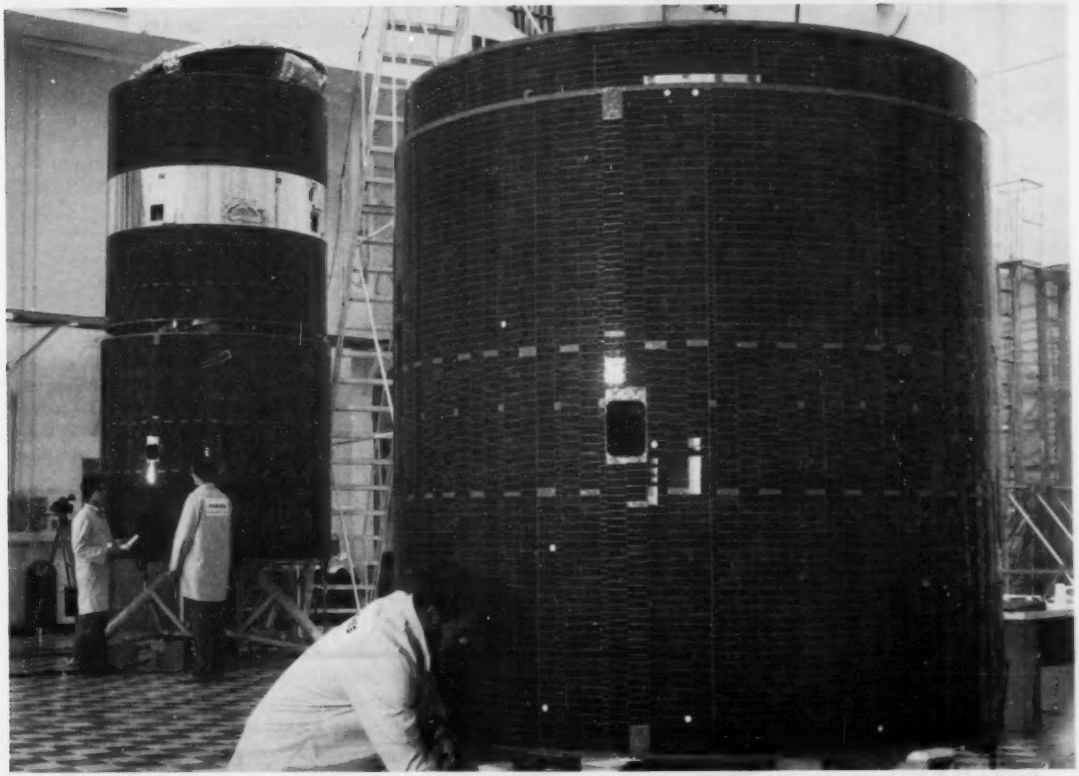
will develop and promote selected civil applications of space technology. Progress in these areas will require substantial efforts by both government and the private sector. Only by working in harmony can we jointly sustain American leadership.

Perhaps as important as the policy is the President's formation of a mechanism to implement that policy. This mechanism is the new Senior Interagency Group for Space—SIG(Space). While the policy document establishes the broad framework for the conduct of the space program, SIG(SPACE) will provide a forum for addressing major policy issues necessary to execute the overall program. SIG(SPACE), which will hold its first meeting later today, demonstrates the President's firm determination to resolve major issues affecting the ability of the United States to maintain its leadership in space.

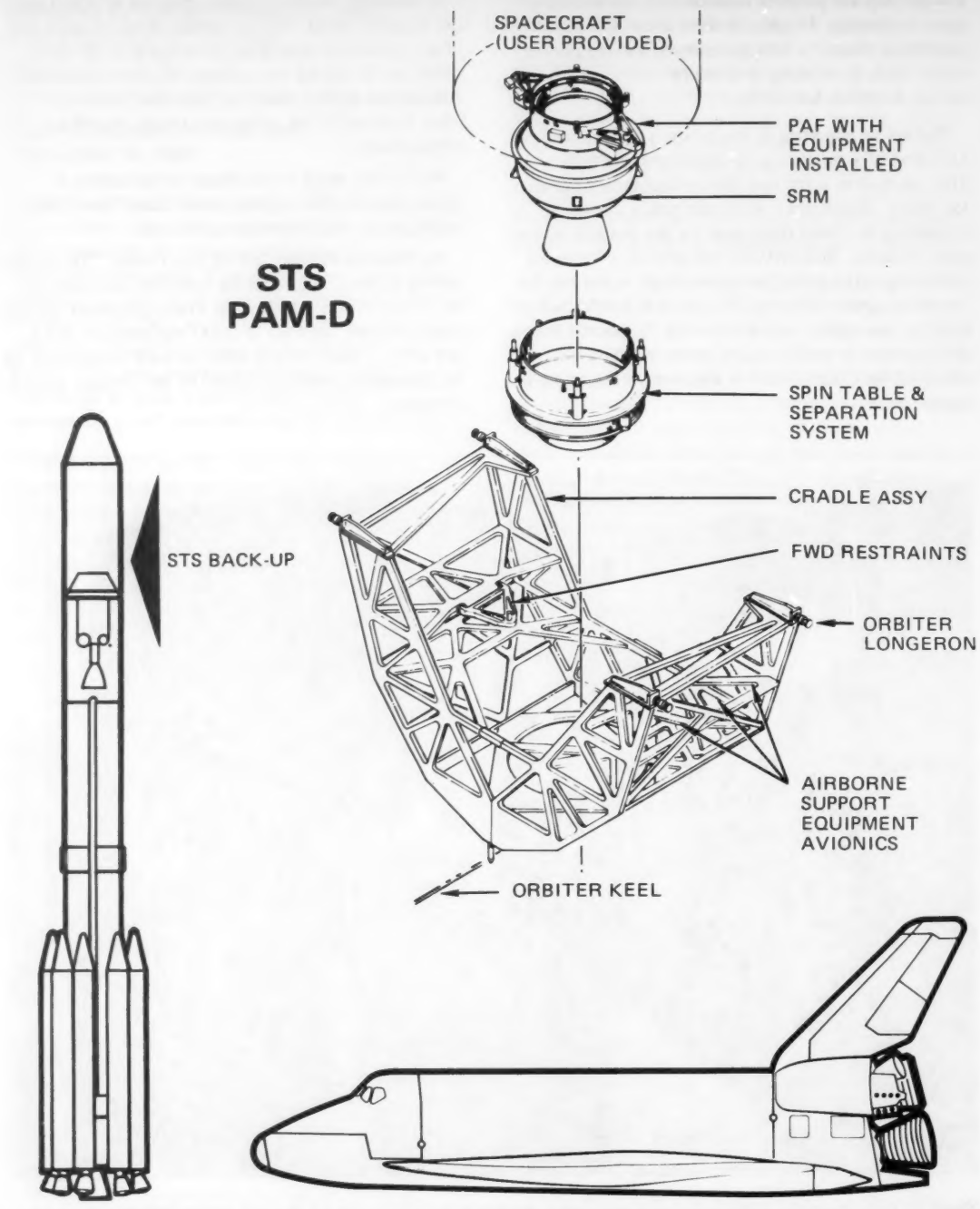
In summary, we have a space program of which we can be justly proud. The late Justice Brandeis once said, "There is in most Americans some spark of idealism, which can be fanned into a flame. It takes sometimes a divining rod to find what it is, but when found and . . . when bestowed to the owner, the results are often extraordinary."

We've seen many extraordinary achievements in space since the 1967 signing of the Outer Space Treaty, and there are even better things to come.

As President Reagan said on July Fourth, "The fourth landing of the Columbia is the historical equivalent to the driving of the golden spike which completed the first transcontinental railroad. It marks our entrance into a new era . . . now we will move forward to capitalize on the tremendous potential offered by the ultimate frontier of space."

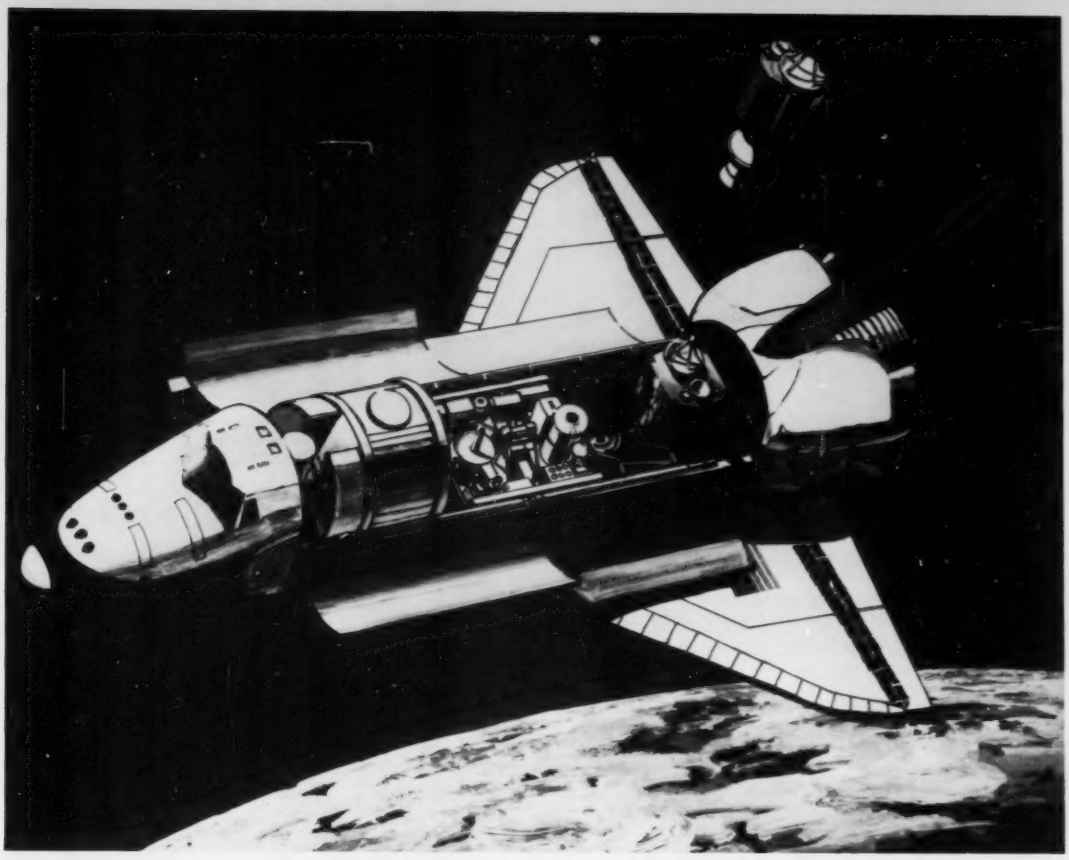


Shuttle 5's Prime Payloads—Technicians work on solar panel mechanisms on two satellites that will be carried into low Earth orbit on the first operational mission of the Space Shuttle: Telesat-E, called ANIK-C in orbit (back left), and Satellite Business Systems-C (front). Each satellite will be deployed from the orbiter's payload bay by a new spinning ejection system; each will later reach geosynchronous orbit using a Payload Assist Module (spinning solid upper stage).



DELTA 3910/PAM

NASA Verification, Installation & Operations
(MDAC Support)



New Satellite Launcher—Under agreement with NASA, McDonnell Douglas has developed two configurations (diagram at left) of a spinning solid upper stage called the Payload Assist Module (PAM). PAM-D (Delta class) and PAM-A (Atlas Centaur class) will provide perigee orbital injection when satellites are launched from the Space Shuttle. PAM-D is designed to be compatible with both the Shuttle and the Delta expendable launch vehicle in order to provide a backup capability for early Shuttle missions. Photo at top shows artist's concept of satellite deployment using the Payload Assist Module.

NASA Participates in Gimbels' "Touch Tomorrow Today"

In an agency first, NASA participated in a major "storewide" futuristic exposition called "Touch Tomorrow Today" sponsored by Gimbels department store of New York. The agency's collection of displays and models was the largest NASA exhibition ever to appear in New York. Gimbel's total exposition, from Sept. 19 through Oct. 8, featured over 40 exhibitors, covered 25,000 square feet of space on nine floors and drew approximately one million spectators.

The three-week event was hailed by Gimbels as a "forum for American industry, government and arts"—an opportunity for the American public to find answers to questions about what the future holds in the areas of communication, science, space, recreation, the arts, working and living in space, clothing, money, and education.

The focus for "Touch Tomorrow Today" was on participation and public information—not commercialization. Gimbels assured NASA that at no time would agency exhibits be used as an endorsement or promotion of sales either in the store or in media advertisement of the exposition.

The Gimbels exposition featured exhibits on aerodynamics, space technology, computers, arts, energy, environment, recreation and fashion were

gathered from major U.S. manufacturers, government, universities and scientists to provide the public with a preview of life in the eighties and beyond.

Participants included: NASA, Alabama Space and Rocket Center, Alfred University, Black & Decker, Bulova, Clarkson College of Technology, Compuvision, Ford, FTC Services, Man-Made Fiber Association, Massachusetts Institute of Technology, Milton Bradley, New York Institute of Technology, New York Telephone, International Institute of Applied Technology, Philadelphia College of Art, Omni, Polaroid, Rensselaer Polytechnic Institute, Seiko, Sony, Syracuse University, Techniclothes, and Vectrex.

NASA astronauts Thomas K. Mattingly and Henry W. Hartsfield, the crew of the fourth Space Shuttle mission, officially opened the exposition on Sept. 19 with a ribbon-cutting ceremony. They later narrated a film report on their flight, the final mission in the Space Shuttle orbital test flight series, in Gimbels sixth floor auditorium.

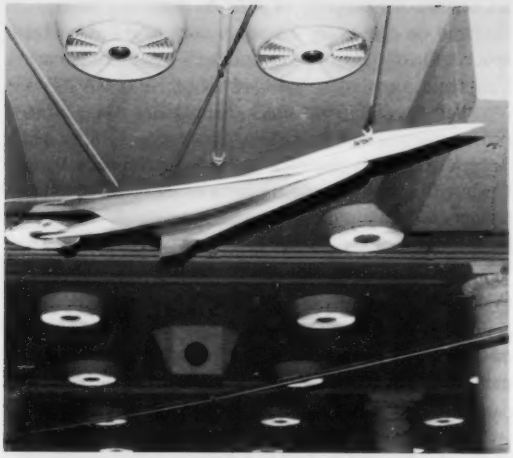
NASA was the largest participant in "Touch Tomorrow Today": the agency was given exclusive use of the fourth and seventh floors of Gimbels for exhibits and shared space with other participants on the first and sixth floors.

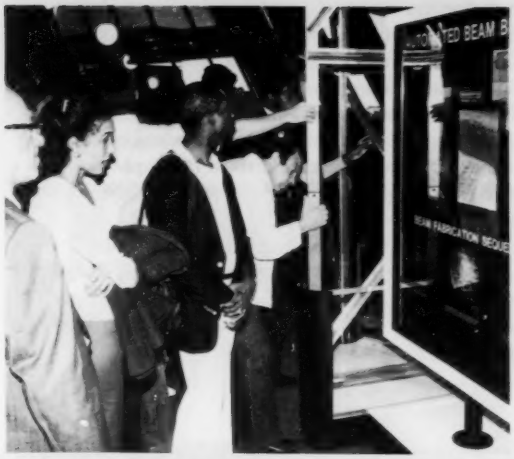
NASA's experimental wind tunnel model of the supersonic cruise research aircraft was featured on the first floor. Also on display were two murals: an artist's rendering of the Shuttle servicing a future space station and a photomural of a Space Shuttle launch.

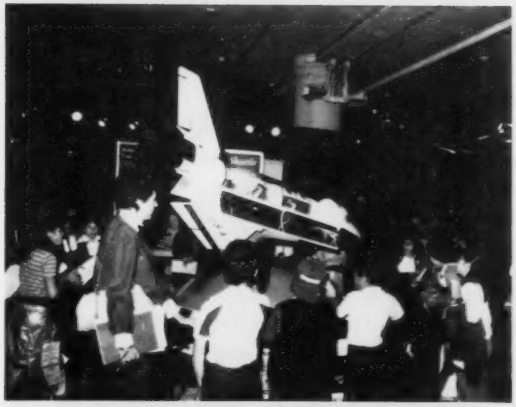
On Gimbels fourth floor, NASA exhibits included the Lunar Rock, one of only two touchable moon rocks on exhibit in the world; and beam builder, spacelab, and space suit displays. Panels showed future space station concepts: space platform, a design study conducted at NASA's Marshall Space Flight Center, Huntsville, Ala., and a space operations center, developed at NASA's Johnson Space Center, Houston. Video presentations included "Jupiter, the Giant" and "Fun in Space."

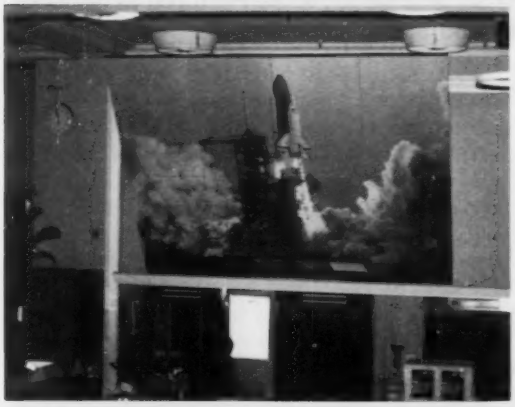
On the sixth floor, NASA presented five lectures a day on aeronautical and space sciences. The half-hour lectures and demonstrations were given by space technology experts from NASA and covered subjects such as rocketry—up to and including the Space Shuttle; space science information on the moon and the planets of the solar system; and the latest innovations in aeronautics and spinoff technologies. In addition, reproductions of paintings from NASA's art program were on display which featured twelve works by America's leading artists.

Finally on Gimbels seventh floor, NASA's exhibits focused on the applications of space technology with









Scenes from NASA's exhibition at "Touch Tomorrow Today" a futuristic exposition sponsored by Gimbels department store of New York from Sept. 19 through Oct. 8. NASA's collection of displays and models was the largest agency exhibition ever to appear in New York. NASA astronauts, T. K. Mattingly and Henry Hartsfield, crew of the fourth Space Shuttle mission, officially opened the exposition on Sept. 19 with a ribbon-cutting ceremony.

such displays as: a scale model of the Space Shuttle highlighted by panel displays explaining the role of the Shuttle in the future—its use as a "space truck" for earth-orbiting laboratories, solar power satellites, space stations and interplanetary mission launch platforms. Other panel displays discussed the personal, home, medical and health benefits derived from space technology, including the development of fire-resistant materials.

Curators for Gimbels "Touch Tomorrow Today" exposition were Robert P. Gersin Associates, designers for exhibitors at three World's Fairs including Expo '82 in Knoxville and the U.S. Pavilion at the 1975 World's Fair in Japan.

NASA Shuttle Art to be Featured at National Air and Space Museum

NASA's Space Shuttle program has been captured in a unique type of archival history: art. This ever expanding collection of over 200 works of art tells the Shuttle story in widely varying concepts—from abstract fantasy to photographic realism—and in artistic mediums that range from pencil sketches to oil paintings.

From Nov. 30 through July 1983, a special collection of NASA's Space Shuttle art will be featured at the National Air and Space Museum, Washington, D.C. Following this eight-month showing, the collection will be sent to major cities across the nation on a 1-2 year traveling art tour, sponsored by the Smithsonian Institution Traveling Exhibit Service (SITES).

The NASA art program began in 1962 at the recommendation of Administrator James Webb who saw the need to use interpretive artwork as a means of documenting the "spirit as well as the sights of the space age."

The first group of artists was dispatched to cover Gordon Cooper's final Mercury flight in May 1963. Documenting the next ten years of spaceflight through the Gemini and Apollo program were such famous artists as Norman Rockwell, Jamie Wyeth and Robert Rauschenberg.

In 1976, NASA's graphics coordinator, Robert Schulman, was asked to revive the agency's art program for the new age of the Space Shuttle; it had become dormant after the agency's space race for the moon during the decade of the seventies.

Artists who agree to participate in the agency's art program donate their time and talent in return for an honorarium to cover expenses; their finished works of art become the property of NASA. And they have captured on canvas the Shuttle's story as it has evolved: spacecraft rollout from the Rockwell assembly plant in California; simulation and hardware tests at NASA's Marshall Space Flight Center, Huntsville, Ala.; orbiter processing work in the Orbiter Processing Facility and Vehicle Assembly Building at NASA's Kennedy Space Center, Fla.; the historic moment of the first launch pad rollout; and finally the unique aerospace vehicle's launch and landing.

Artists participating in the Shuttle art program bring to the assignment a wide range of talent and artistic approaches to the subject matter and include such modernists as Lamar Dodd and Robert Rauschenberg; traditional illustrator Arthur Shilstone; Bob McCall, participating member since the inception of the agency art program in the sixties, who designed the advertising art for the film 2001: A Space Odyssey; Wilson Hurley, noted for his Western landscapes; Bill Robles, courtroom illustrator for the Charles Manson trial in the late 1960's; and Henry Casselli, first official Marine combat artist in Viet Nam.

NASA's Shuttle artists are free to interpret the subject matter of their choice—no one within the agency dictates how they should work or what is expected of their final product.

As Bob Schulman, NASA art program coordinator explains: "Although the artwork produced for the Space Shuttle collection presents a wide range of techniques and styles from the very realistic approach to abstract images and impressions, the "harmony" is obvious to those who have the privilege of viewing this fine work. Each painting depicts an intimate human record for future generations to view some very exciting moments of the Space Shuttle story as seen through the eyes of the artist. Along with documenting the space effort in every way possible, these paintings stand on their own as works of art."

The artists participating in the NASA art program join an established heritage of recording historic events through art—including the settlement of the West, the Civil War and World Wars I and II.

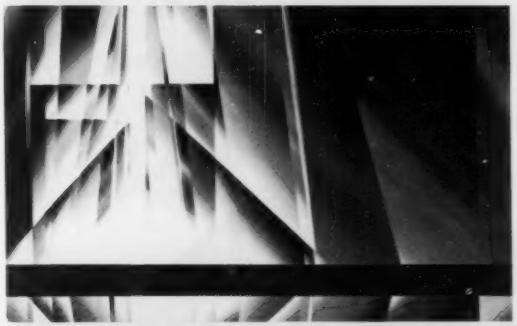
For many of the artists, a great challenge lies in covering the excitement of a Shuttle liftoff on canvas. After the first Space Shuttle launch, artist Wilson Hurley commented: "The launch is the most exciting event I have witnessed in my life, and it will probably take me years to assimilate my feelings to where I can produce paintings that come close to the thrill it gave me."

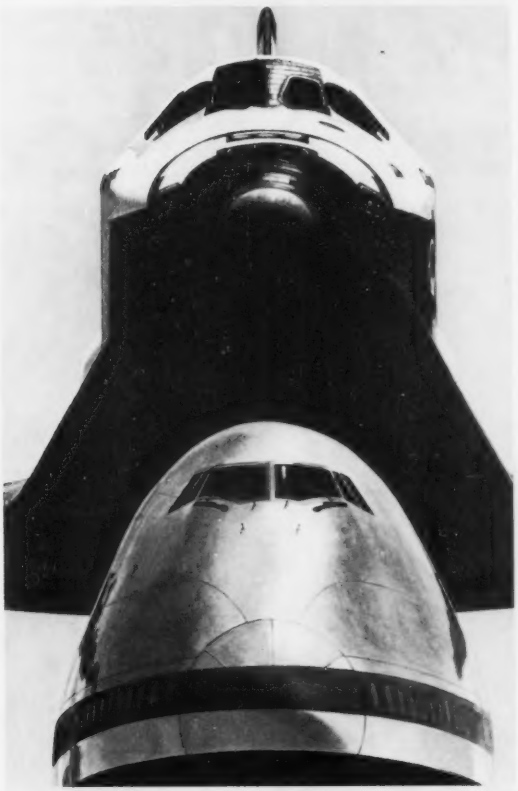
The technology of the Space Shuttle program also captured artistic imaginations. "My first thought," said

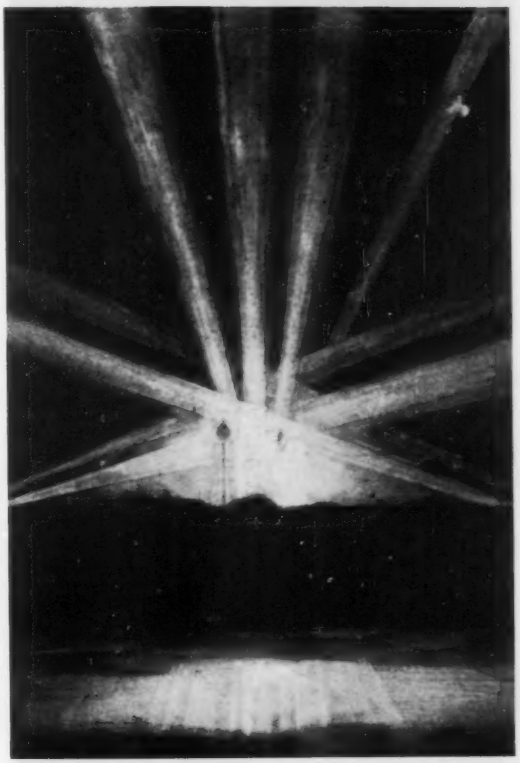
illustrator Paul Salmon, "was to not get involved in drawing technical equipment and machinery because I do people subjects. But once you get out there (Kennedy Space Center) you realize there is so much humanity—even a tossed-aside hunk of metal can look like a well thought out piece of art because the craftsmanship is so superior. The humanity is in the thousands who have designed and created those things."

And NASA artists found Space Shuttle astronauts to be highly complex as well as fascinating human subjects for their work. Artist Henry Casselli recounting his experience covering astronauts Young and Crippen said: "These men at the same time were ordinary and extraordinary, heroes on the one hand and working men with a job to do on the other, regular guys who could trade jokes with you one minute and then visibly "go within themselves" just before the launch itself."

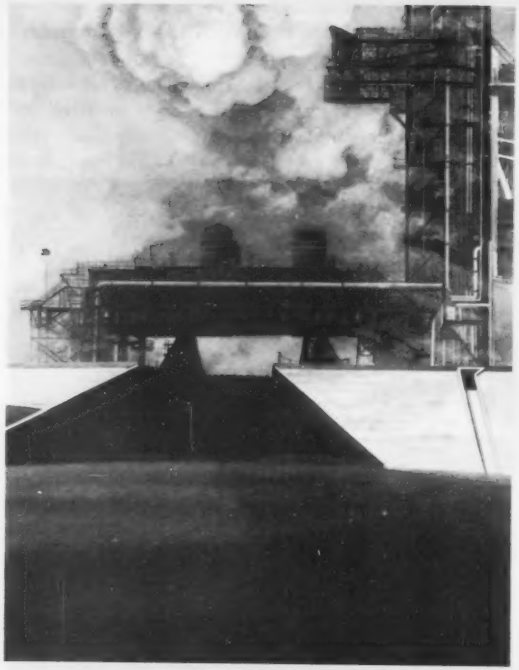
As for how Space Shuttle engineers and scientists regard the contributions made by NASA's art program, illustrator Paul Salmon responds: "I suppose that some of them might laugh at our interpretations of what they do, but the funny thing is that later they'll have the paintings hanging on their wall."

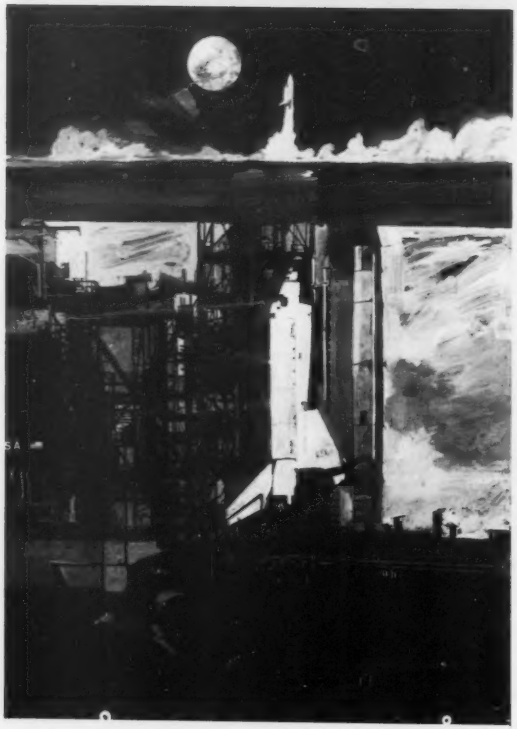






Selections from NASA's collection of Space Shuttle art to be featured at the National Air and Space Museum, Nov. 30 through July 1983. **This page, left column:** "Challenger, Edwards Air Force Base, July 4, 1982," acrylic by Ron Cobb. **Right column, top:** "Florida Coast—Sunset," acrylic by James L. Cunningham; **right column, bottom:** "Night Watch," watercolor by James Dean. **Page 22, top left, clockwise:** "T plus 2:11," acrylic by Linda S. Richards; "The Aftermath," watercolor and gouache by Charles Schmidt; "Columbia at 30 Seconds," oil by Wilson Hurley; and "On the Pad and Launch," acrylic by Paul Salmon.



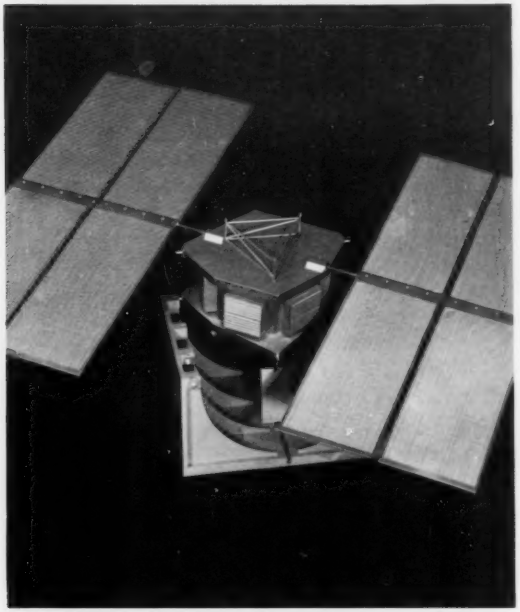


Potential of Mini Space Platform to be Studied

NASA and Fairchild Space and Electronics Co., Germantown, Md., have signed a Memorandum of Understanding initiating discussions for a new on-orbit mini space platform to be serviced by the Space Shuttle. Under the memorandum, NASA and Fairchild will study the potential for a joint endeavor agreement leading to development of a small space platform to be on orbit and available to commercial customers by 1986. Fairchild would be responsible for leasing room on the platform commercially, as well as for providing technical and administrative support for the venture.

The platform, called Leasecraft, would be orbited by the Shuttle and left in space indefinitely. The Shuttle would then return periodically to install or remove payloads. The platform itself would provide the various payloads with power, stabilization, communications and the ability to change orbit.

The lower cost and the flexibility of Leasecraft versus satellites that incorporate all of the hardware for the services to be provided by the platform, is expected to attract widespread commercial and government interest.



Artist concept of Leasecraft (left), a mini space platform that could be placed on orbit and available to commercial customers by 1986. Leasecraft is a concept currently under study via a joint endeavor agreement between NASA and Fairchild Space and Electronics Co., Germantown, Md.

NASA Names Tenth Shuttle Mission Astronaut Crew

Four of the five crew members who will man the Space Shuttle on its first dedicated Department of Defense mission have been selected: NASA astronauts Thomas K. Mattingly, commander; Loren J. Shriver, pilot; Ellison S. Onizuka and James F. Buchli, mission specialists. The fifth crew member, an Air Force manned spaceflight engineer, will be named at a later date.

The tenth flight of the Space Shuttle is currently scheduled for launch from the Kennedy Space Center in the last quarter of 1983. This flight will be the fourth mission using the Space Shuttle Challenger.

Thomas K. Mattingly

Loren J. Shriver

Ellison S. Onizuka

James F. Buchli

Computer Simulations Speed Up NASA's Aeronautical Research Programs

As the pilot breaks through the bottom layer of clouds in a leaden sky, he can just see the rain-washed decks of the destroyer in the rolling seas about 500 feet below him. He's flying a new type of plane. It's a tactical aircraft called a Harrier, and it has four movable nozzles that allow the thrust of its single jet engine to be directed either aft for conventional flight or downward for vertical takeoff and landing and for hovering.

As the ship rides to the crest of each long swell and then slides into the trough, the landing deck in the stern alternately rises and falls a total distance of some 30 feet. The pilot is holding the plane stationary now, directly above the ship, hovering, waiting for the one right exact moment to ease down and meet the heaving deck. All four nozzles are directed downward, providing lift, but no forward motion. The landing will be tricky at best. The last time, he crashed. But he learned something then, and this time he'll make it.

Actually, *the last time was five minutes ago,* and there were no injuries or damage to the plane or ship because the pilot never moved away from his TV monitor. It's all part of an amazingly realistic on-the-ground training flight that's being computer-simulated, and it's just one example of how scientists at NASA's Lewis Research Center are using computers in aeronautical research.

The program for this simulation, which improves computer execution time ninefold, was written at Lewis. It had to be developed specially because both propulsion and flight control on the Harrier are provided by the plane's jet engine, making for unique handling characteristics.

Lewis is NASA's lead aeropropulsion center, working in concert with other NASA aeronautics research facilities emphasizing airframe technology (Langley Research Center, Hampton, Va.) and flight testing (Ames Research Center, Moffett Field Calif., where the flight simulator is located.)

At Lewis, computers aid aeropropulsion research in a number of related areas: propulsion, propulsion aerodynamics, fluid mechanics, aerothermodynamics and fuels, and structures and mechanical technologies. In each area, computers are being used to:

- *Simulate and predict* what will happen outside in the real world by using mathematical models that stay inside the computer;
- *Gather and integrate* massive amounts of data that the latest technology and monitoring devices can generate in a short time;
- *Analyze and correlate* all of the computations to provide scientists and engineers with the necessary understanding of the aerodynamic, structural and propulsion phenomena that must be coordinated and unified into a just-so-combination to design and build a modern aircraft.

In effect, computers can help design aircraft engines of the future, or improve those operating now, at a fraction of the cost, in time and money, otherwise required, if indeed the engine wanted can be built at all.

Savings are achieved by Lewis researchers primarily in three ways: (1) design and concept testing can be done before any actual hardware need be built, (2) a more advanced design is possible when prototype hardware is constructed, and (3) test time for hardware in wind tunnels and in test aircraft is shortened dramatically, saving, in some instances, years of testing time.

Besides doing them cheaper, computers at Lewis do some tasks now that were impossible before what one NASA scientist has called the "age of computational plenty." Due to sheer size and the number of calculations needed to reach a solution, some problems were, for all intents and purposes, unsolvable in the "slide rule age." In fact, certain computations done easily by today's computers would have taken so long on the computers of yesterday that the time required to solve them would have exceeded the life expectancies of the old machines.

For example, in the design of jet engine inlets and nozzles, engineers no longer have to settle for the simplifying assumptions required for two-dimensional computer analysis. Three-dimensional analysis and the extra computational load it imposes now can be absorbed with the greater capacity of modern computers. New computers also are making possible the great strides achievable in propeller design for high-speed aircraft of an extremely advanced design that has the potential of giving a plane jet-powered performance on one-third less fuel.

Lewis scientists now are finding potential in another area to do things that simply weren't possible in the past. When combined with the nonintrusive measurement capability of a laser beam, for example, computers appear to have the ability to find areas for design improvement that cannot be reached with mechanical probes and from which data could not be gathered because of their physical inaccessibility.

Use of computer graphics (computer-generated images that are shown on a TV-type screen) permeates all Lewis efforts in aeronautical research. One example involves the study of what goes on inside the

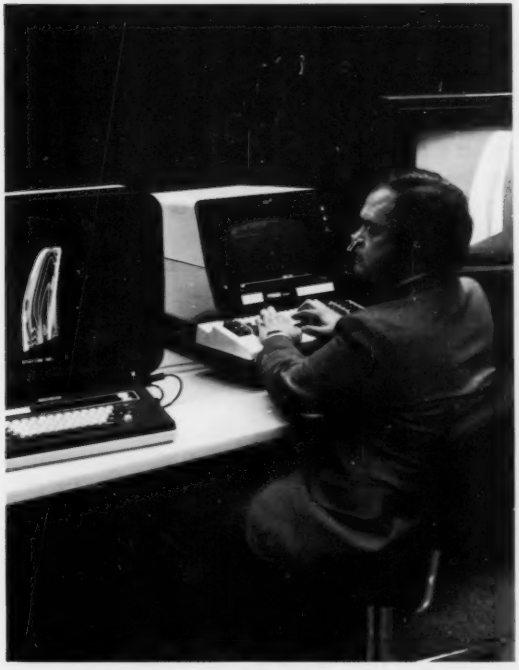
combustor, the part of a jet engine in which the fuel and air are burned. By factoring into a computer program such variables as the type of fuel, method of injection into the combustor, and the temperature and pressure of the fuel/air mixture, a visual representation of the combustion process can be generated. As each variable is changed by giving the computer new instructions, the effect on the combustion process can be observed. What actually appears on the screen resembles a color time-lapse movie of storm clouds moving across the sky and helps designers gain an understanding of the combustion process that isn't possible from just looking at equations and tables of numbers.

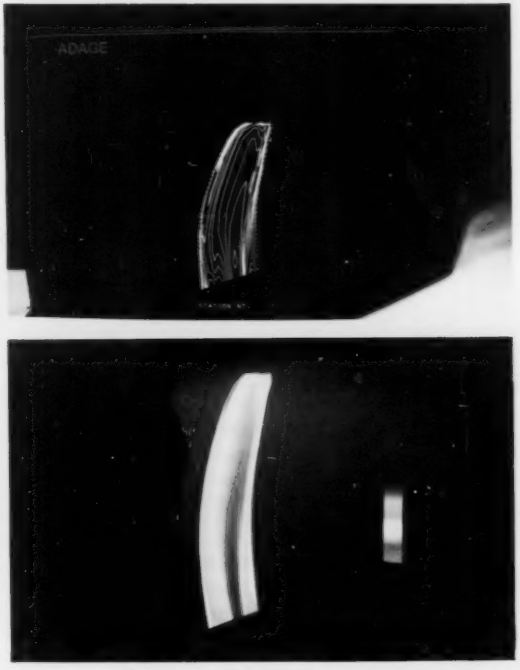
But the study of the principles of operation and the processes inside a modern jet engine presupposes the existence of the engine itself. That, too, must be designed and then built. Hence, the study of structures and mechanical technologies and research in the field of tribology, which deals with lubrication, friction, wear and the general process of what happens when moving parts move togehter.

In the area of computational structural mechanics, for instance, computers are used to analyze the effects of temperature and load variations on a component. Here, using the computer, Lewis engineers can perform much more complex, thorough and realistic testing than is possible by putting a part into even the most advanced test equipment.

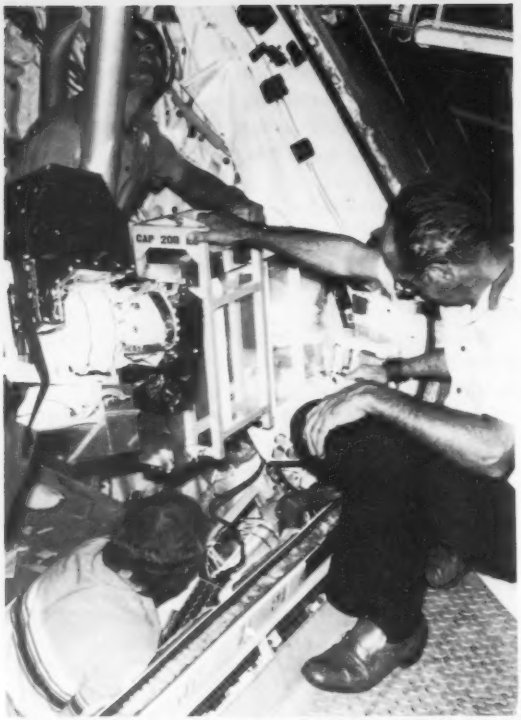
Programs exist that will evaluate the structural response of a turbine blade to aerodynamic, thermal, centrifugal and impact loadings on a part. Even the impact of a bird on a fan or compressor blade can be simulated.

Lewis' capability for computer research will have expanded even further by the end of the year, when the installation of a new computer that will be four to ten times faster than current equipment will be completed. Because much more trial-and-error work will be done much faster by using mathematical models, experimental facilities such as wind tunnels can be used for fewer and shorter runs, thus not only saving time but conserving energy as well.





Use of the latest in computer technology illustrated in this application of graphic analysis to propeller research. A new analytical tool, the three-dimensional Euler lifting surface propeller computer analysis (photo at left) has been developed to design propellers for high subsonic speed aircraft. The different speeds of the air flowing over particular portions of those advanced propeller blades are predicted by the program and are represented as a line drawing (top right). Color is added (bottom right) to the computer generated image to show the areas of varying air speed. Red is used to indicate the highest air speed (the color assigned to the triangular shape in the line diagram) yellow to indicate the intermediate speeds, and blue, the lowest air speed.



New Communications—Workers install a new Ku band antenna in the payload bay of the orbiter Challenger in Kennedy Space Center's Orbiter Processing Facility. This device will allow the spacecraft to communicate with an advanced Tracking and Data Relay Satellite in a high frequency range much less crowded than the S-band now used. The first flight of Challenger is scheduled for Jan. 1983.

Marshall Concludes First of Two-Part Contract on Robotics

Robots have long been associated with spaceflight and spacecraft in the movies and popular press. But except for robotic devices such as the Space Shuttle's remote manipulator arm, use of robots in space has been limited thus far.

NASA, however, sees potential for real-life cousins of the movie robots. Marshall Space Flight Center in Huntsville, Ala., under funding from NASA's Office of Aeronautics and Space Technology, has been working with the Massachusetts Institute of Technology, Cambridge, on a study to see how they might best be used in space. The study addreses both robotics and an even more exotic, related field called "telepresence."

The first phase of this two-part study was recently concluded, according to the Marshall Center's study manager George Von Tiesenhausen. "The purpose is to make future missions more affordable," said Von Tiesenhausen, "by having humans doing only those tasks they do best. Humans have dexterity and can do delicate work, and they are better prepared to deal with unexpected events and make on-the-spot decisions. And humans can intervene when machines fail. Machines, on the other hand, can take over failure diagnosis and maintenance tasks, and can do 'housekeeping'—for example, keep the on-board systems running."

In the part of the study just completed, MIT examined three areas. "First," said Von Tiesenhausen, "the institute was to investigate what kinds of tasks have been planned in space over the next 15 years or so. Secondly, it was to research the state-of-the-art over the next decade or more. Thirdly, MIT was to match the two—the automation and the tasks—to find for each activity the automation available."

In the study, the institute arrived at some 70 generic activities that cover a broad spectrum of missions. The activities were then arranged into an organized format. "Marshall is the first to organize the technology of automation," said Von Tiesenhausen. "There was no structure within the entire automation community before now.

"And the matching of tasks with automation has a broad-brush effect—we can use these matches when a project manager wants to review what's available for a specific project he's proposing for the future."

The second part of the contract now underway concerns "telepresence," and is a specific application extracted from the first part of the contract. "The idea of telepresence evolved from MIT's Marvin Minsky, and the concept involves a lot of automation," said Von Tiesenhausen. "The example I'm fond of using is 'driving a car by telepresence': you'd get into a remote control device in New York and drive an empty car through traffic in Los Angeles. In the machine in New York, you would have a lot of sensors strapped to your hands and legs, and you would see what the camera saw from the empty automobile in Los Angeles. If you turned your head to the left or right, the camera in the Los Angeles vehicle would do the same. With telepresence, you could do things in space as if you were really there."

The telepresence half of the MIT study contract will run until May 1983. It will concern itself with two questions: Based on present automation technology what technology gaps must be filled in order to build an initial telepresence system and what kind of demonstration program is needed to verify telepresence applicability to space tasks.

"Our present robotic equipment is much too heavy and clumsy for telepresence," said Von Tiesenhausen. "An automated arm, for example, weighs 900 kilograms (20,000 pounds) and requires 10 horsepower to run it. A human arm weighs 4.5 kg (10 lb.) and needs only a few watts. That's one of the differences between human and robotic capabilities.

Patents for Inventions from NASA Research

The Office of General Counsel, NASA Headquarters, announces that the following U.S. patents have been issued by the U.S. Patent and Trademark Office to NASA for inventions resulting from NASA research. Inquiries concerning them should be directed to the attention of the NASA Patent Counsel of the indicated installation.

Inventor(s) & Employer	Title	Patent No.	Installation
James S. Sovey, Ralph Forman, Arthur N. Curren and Edwin G. Wintucky, NASA/LeRC	Ion sputter textured graphite	4,349,424	LeRC
Percy H. Rhodes and Robert S. Snyder, NASA/MSFC	Electrophoresis device	4,349,429	MSFC
Bruce A. Banks, NASA/LeRC	Mechanical bonding of metal	4,349,954	LeRC
Peter O. Minott, NASA/GSFC	Multiprism collimator	4,350,410	GSFC
Glen E. McDonald, NASA/LeRC	Method for depositing an oxide coating	4,350,574	LeRC
Carlisle R. Dolland and Daniel W. Trimble, Airesearch Mfg. Co., Torrance, Calif.	Combinational logic for generating gate drive signals for phase control rectifiers	4,351,022	MSFC
Jan Harper-Tervet, Warren L. Dowler, Shiao-Ping S. Yen and William A. Mueller, Caltech/JPL	Coating for gasifiable carbon-graphite fibers	4,351,878	NRO/JPL

Space Shuttle Launches for 1982

Orbiter	Launch Date	Launch Site	Payload
*Columbia (OV-102)	March 22	KSC	OSS-1
*Columbia (OV-102)	June 27	KSC	DOD 82-1
Columbia (OV-102)	November 11	KSC	SBS-C, ANIK-C

* Successful launch

Expendable Launches for 1982

Name	Launch Date	Vehicle	Range	Mission Remarks
*RCA-C	January 15	Delta	ESMC	RCA communications. Reimbursable.
*Westar-IV	February 25	Delta	ESMC	Western Union communications. Reimbursable.
*Intelsat V-D	March 4	Atlas Centaur	ESMC	Intelsat communications. Reimbursable.
*Insat 1-A	April 10	Delta	ESMC	India communications. Reimbursable.
*Westar-V	June 8	Delta	ESMC	Western Union communications. Reimbursable.
*Landsat-D	July 16	Delta	WSMC	NASA earth resources applications.
*Telesat-G (Anik-D1)	August 26	Delta	ESMC	Canada communications. Reimbursable.
*Intelsat V-E	September 23	Atlas Centaur	ESMC	Intelsat communications. Reimbursable.
*RCA-E	October 27	Delta	ESMC	RCA communications. Reimbursable.

* Successful launch

Another Dividend from Air and Space

Research and development in aeronautics and space have provided numerous benefits for all Americans—and at a tiny percentage of the tax dollar. Here is an example:

Pocket-Size Electronic Detective

An aerospace spinoff of electronic circuitry has produced the Electronic Nose*, a device which detects flammable liquid "accelerants" in post-fire situations where arson is suspected. Accelerants are combustibles such as gasoline or benzene which are used by arsonists to speed up the spread of fire. Deliberately-set fires kill more than 1,000 people per year across the nation and cause injuries to thousands more, at a cost of about $5 billion annually.

Speedy detection of physical evidence by the "Nose" has helped expedite arson investigations by law enforcement agencies, firefighters and insurance companies.

The small pocket-size device is powered by a rechargeable battery and is so simple to operate that users need no special training. The investigator holds the Electronic Nose about an inch above the suspected material; if an accelerant is present it will trigger the "Nose" to beep and emit a flashing light. The faster the beep, the more volatile the accelerant.

The extremely sensitive device can detect the presence of accelerants several days after a fire and in such minute trace quantities as less than 50 parts per million.

The Electronic Nose is also useful in other applications such as detecting hazardous fumes, locating gas spills that have seeped into sewer systems and detecting gas leaks in refineries and on oil drilling rigs. Manufactured by Grace Industries, Inc., Transfer, Pa., about 1,000 units are produced per year. Electronic Nose is presently used in criminal justice courses taught at the University of Texas, Austin, and in seminars conducted by Dr. Richard W. Henderson (shown in photo) at Francis Marion College, Florence, S. Car.

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* NASA does not endorse commercial products developed as a result of its Technology Utilization or Patent Licensing Programs, but it does encourage the widest possible use of its technology.